Claims:

1. A method for determining the hardening depth of a ferro or ferrimagnetic substance, in which method

- a varying magnetic field in created in the measurement object,

- the Barkhausen noise arising from the varying magnetic field, and which originates from the measurement object, is measured, and

- the value depicting the energy of the measured noise is determined, for example, by integration or summing, and

- the hardening depth of the measurement object is determined on the basis of the value depicting the energy of the noise,

characterized in that

- the varying magnetic field created in the measurement object is regulated, in such a way that the maximum strength of the magnetic field is at most 110 % of the value of the coercitive force of the hardened part of the object being measured.

2. A method according to Claim 1, **characterized** in that the noise signal measured is converted to the frequency level, for example, with the aid of a discrete-time Fourier transformation, such as FFT transformation.

3. A method according to Claim 2, **characterized** in that the value depicting the energy of the measured noise is determined by integrating the noise signal converted to the frequency level, over a specific frequency band, such as 10 - 1200 Hz.

4. A method according to any of Claims 1 - 3, **characterized** in that the hardening depth

of the measurement object is determined on the basis of the value depicting the energy of the noise, with the aid of a table or formula, which is defined with the aid of test measurements.

5. A method according to any of Claims 1 - 4, **characterized** in that the varying magnetic field created in the measurement object is regulated in such a way that the maximum strength of the magnetic field does not exceed the coercitive force of the hardened part of the measurement object, but does exceed the coercitive force of the unhardened part of the measurement object.

6. A method according to any of Claims 1 - 4, **characterized** in that the magnetic field created in the measurement object is regulated in such a way that the maximum strength of the magnetic field is at most 105 % of the value of the coercitive force of the hardened part of the measurement object.

7. A method according to any of Claims 2 - 6, **characterized** in that

- the measured noise signal is converted to the frequency level with the aid of a Fourier transformation, such as FFT transformation, and

- the sampling frequency used in the measurement and conversion and the frequency of the varying magnetic field created in the measurement object are essentially synchronized with the frequency of the power-supply network, and

- the measurement time is essentially a multiple of the periods corresponding to the frequency of the varying magnetic field created in the measurement object.

8. A method according to any of Claims 1 - 7, **characterized** in that the frequency of the varying magnetic field created in the measurement object is less than 10 Hz.

9. A method according to any of Claims 1 - 7, **characterized** in that the frequency of the varying magnetic field created in the measurement object is less than 20 Hz.

10. A method according to any of Claims 1 - 9, **characterized** in that the magnetic Barkhausen noise caused by the varying magnetic field is measured with the aid of a coil sensor, which is optimized for low frequencies, i.e., for example, 10 Hz - 2 kHz.

11. An arrangement for determining the hardening depth of a ferro or ferrimagnetic substance, which arrangement includes

- a magnetization coil (13) for creating a varying magnetic field in the measurement object,

- a sensor (14) for measuring the magnetic Barkhausen noise originating from the measurement object, which is caused by the varying magnetic field,

- an apparatus (4), which is arranged to determined the value depicting the energy of the measured magnetic Barkhausen noise and to determine the hardening depth of the measurement object on the basis of this value,

characterized in that the arrangement includes

- a magnetization circuit (10), which is arranged to regulate the varying magnetic field created in the measurement object, in such a way that the maximum strength of the magnetic field is at most 110 % of the value of the coercitive force of the hardened part of the measurement object.

12. An arrangement according to Claim 11, **characterized** in that the apparatus (4) is arrangement to convert the noise signal measured using the sensor (14) to the frequency level, for example, with the aid of a discrete Fourier transformation, such as FFT transformation.

13. An arrangement according to Claim 12, **characterized** in that the apparatus (4) is arranged to determine the value of the energy of the measured noise by integrating the

noise signal converted to the frequency level over a specific frequency band, such as 10 - 120 Hz.

14. An arrangement according to any of Claims 11 - 13, **characterized** in that the apparatus (4) is arranged to determine the hardening depth of the measurement object, on the basis of the value depicting the energy of the noise, with the aid of a table or formula, which is defined with the aid of test measurements.

15. An arrangement according to any of Claims 11 - 14, **characterized** in that the arrangement includes a magnetization circuit (10), which is arranged to regulated the magnetization current fed to the magnetization coil (13) and the magnetic field created by the magnetization current, a magnetization flux measurement circuit (8), which is arranged to measure the magnetization flux created by the magnetization coil , with the aid of the coil (12), and/or a magnetization current measurement circuit (9), which is arranged to measure the current travelling through the magnetization coil (13).

16. An arrangement according to Claim 15, **characterized** in that the apparatus (4) is arranged to regulate the strength of the magnetic field created in the measurement object by the magnetization coil (13), with the aid of the magnetization circuit (10), the magnetization flux measurement circuit (8), and/or the magnetization current measurement circuit (9), in such a way that the maximum force of the magnetic field does not exceed the coercitive force of the hardened part of the measurement object, but does exceed the coercitive force of the unhardened part of the measurement object.

17. An arrangement according to Claim 15, **characterized** in that the apparatus (4) is arranged to regulate the strength of the magnetic field created in the measurement object by the magnetization coil (13), with the aid of the magnetization circuit (10), the magnetization flux measurement circuit (8), and/or the magnetization current measurement circuit (9), in such a way that the maximum strength of the magnetic field is at most 105 % of the value of the coercitive force of the hardened part of the measurement object.

18. An arrangement according to any of Claims 15 - 17, **characterized** in that the apparatus (4) is arranged to regulate the strength of the magnetic field created in the measurement object by the magnetization coil (13), with the aid of the magnetization circuit (10), the magnetization flux circuit (8), and/or the magnetization current circuit (9), in such a way that the magnetization flux settles to an essentially constant value, independently of the measurement object.

19. An arrangement according to any of Claims 12 - 18, **characterized** in that the apparatus (4) is arranged to convert the measured noise signal to the frequency level, for example, with the aid of Fourier transformation such as FFT transformation, and to use in the conversion a sampling frequency, which is essentially synchronized with the power-supply network frequency and the frequency of the varying magnetic field created in the measurement object, and a measurement time, which is essentially a multiple of the periods corresponding to the frequency of the varying magnetic field created in the measurement object.

20. An arrangement according to any of Claims 15 - 19, **characterized** in that the apparatus (4) is arranged to regulate the frequency of the magnetic field created in the measurement object by the magnetization coil (13) to less than 10 Hz, with the aid of the magnetization circuit (10), the magnetization flux measurement circuit (8), and/or the magnetization current measurement circuit (9).

21. An arrangement according to any of Claims 15 - 19, **characterized** in that the apparatus (4) is arranged to regulate the frequency of the magnetic field created in the measurement object by the magnetization coil (13) to less than 20 Hz, with the aid of the magnetization circuit (10), the magnetization flux measurement circuit (8), and/or the magnetization current measurement circuit (9).

22. An arrangement according to any of Claims 11 - 21, **characterized** in that the sensor (14) is a coil sensor, which is optimized for low frequencies, i.e., for example, for frequencies of less than 1 - 2 kHz.